RIVERS.

Little of interest occurred in connection with river conditions. In most cases streams were low for the season and the variation during the month was slight.

MISCELLANEOUS.

Northwesterly winds prevailed over much of the district. Gales occurred on the 10th in parts of Iowa and southern Wisconsin, and on the 28th in eastern North Dakota and northwestern Minnesota. The highest velocity reported was 52 miles an hour, at Moorhead, Minn., on the 28th. There was less sunshine than usual in most parts of the district. The average number of clear days was 13; partly cloudy, 7; cloudy, 11.

Press dispatches and a report from the cooperative observer at Mount Vernon, a station in southern Illinois, mention the occurrence of an earthquake at that station on the morning of the 5th. The local extent of the phenomenon is apparent, since no reports were made of it from outside the county in which Mount Vernon is situated. The damage was immaterial.

NOTE.

The following statement is published for the purpose of correcting any erroneous impressions that may have been obtained as to the authority for the location of power sites shown on the Relief Map of Wisconsin, facing page 1022, Monthly Weather Review for July, 1913, and the separate of that bulletin, District No. 5, for the same month:

Messrs. W. O. Hotchkiss and F. T. Thwaites compiled only the data on which the relief map is based and are not responsible in any way for the location of power sites shown thereon. The sites were entered on this map by W. R. Bormann, who obtained their location from a chart prepared by H. A. von Schon, consulting engineer and member of American Society of Civil Engineers, and published in the Water-Power Chronicle of February, 1913.

TORNADOES IN WISCONSIN ON OCTOBER 10, 1913.

W. R. BORMANN, Observer.

On the afternoon of October 10, 1913, several counties in western and southern Wisconsin were swept by severe windstorms. In eastern Vernon and southwestern Juneau counties they were most severe, and one which occurred there in the early afternoon assumed all the characteristics of a tornado. A second and smaller tornado was also reported in the extreme southern part of Rock County later in the afternoon. The writer did not visit the scene the destruction, and this report is based on information received in response to a circular letter which was sent to all postmasters and other individuals in the vicinity of the devastated districts, and on newspaper accounts. After reviewing the letters of reply and the press dispatches, it is conservatively estimated that the total loss to buildings, crops, etc., was about $250,000. One man was killed by lightning and about 30 people were injured, 3 of whom died later. In all cases the physical injuries did not seem severe, but the shock received from the passage of the storm appeared to be the main cause of death. The destruction to crops consisted mostly of damage to tobacco in storage. The Censor, a newspaper published in Viroqua, Vernon County, states that over 100 tobacco sheds were destroyed in that county alone.

The weather map on the morning of October 10 showed a well-developed, energetic area of low pressure central over Manitoba and reaching southward over the upper Mississippi Valley, with barometer readings below 29.3 inches at the center. During the early afternoon of that day southern Wisconsin occupied the southeast quadrant of the low, a typical position for the formation of violent local storms in that section. La Crosse is the nearest regular Weather Bureau station to the scene of the tornado, being about 35 miles from the nearest point of the path of the storm. The official in charge at La Crosse reports the following meteorological conditions as having prevailed during that afternoon:

> Thunder was heard here at 12.27 p. m., and rain began at 12.32 p. m. and lasted until 2.20 p. m. There was nothing unusual in this storm and it was not at all severe, except for a few minutes. No damage was done in this city, except that a few trees were damaged. In North La Crosse the storm was apparently more severe and a few buildings were damaged. Telephone and telegraph lines suffered severely outside of the city. At this station the temperature was high during the night, a maximum of 68.4° being recorded at 3 a. m. It was 64° at 8 a. m. and reached a maximum of 76.5° by noon. The relative humidity was 92 per cent at 8 a. m. and there was a "feeling" as if a storm were brewing.

The principal tornado seems to have originated at Soldiers Grove about 1.30 p. m. This is a little village in the extreme northeastern part of Crawford County. It took a northeasterly course, passing through the Kickapoo Valley, where the towns of Readstown, Liberty, Ross, and Franklin suffered severely. It then took a more easterly course, passing near West Lima, when it again traveled due northeast, being reported next within 3 miles of Hillsboro. The country between West Lima and Hillsboro, a distance of about 15 miles, is sparsely settled, which made it impossible to obtain much definite information as to the storm's movement and destruction between these two places. After leaving Hillsboro it was again observed near Elroy, which is 5 miles northeast of Hillsboro, from whence it proceeded to Mauston, a town of about 2,000 population, where it caused the most serious damage. It reached this point at 2.30 p. m., having traveled a distance of about 45 miles in an hour. Reports from all the foregoing mentioned towns were to the effect that a well-defined, pendant, funnel-shaped cloud with rotary winds was observed. These reports also indicate that the width of the path of the storm ranged from 20 rods to one-half mile. There is no definite evidence that the entire distance of 45 miles was devastated, and there were probably sections in the path of the tornado where the vortex failed to reach the ground and the storm subsided sufficiently to cause very little damage, but from the information obtained there is reason to believe that the storm which struck Soldiers Grove is the same which was seen at Mauston, and that it covered approximately the path as indicated above.

The cooperative observer at Mauston, Mr. E. L. Hitchcock, states that the loss at Mauston amounts to about $100,000, which includes the loss from the total destruction of 5 houses, damage to 100 others, and destruction to shade trees, crops, etc. Newspaper dispatches from Mauston are to the effect that the opera house, Juneau County Bank, Powers Block, and 20 other buildings were unroofed. The Mauston Star also estimated the total loss in and near Mauston at $100,000. It further states that—

> buggies and articles of clothing and furniture were carried for rods and deposited in fields. The Davis and Hiram Barney houses were damaged the most in this section. Fred Riche's poultry houses and outbuildings were all destroyed and his poultry carried away and killed. The storm then swept over to Tremont Street, where the most severe damage was done, every house being more or less wrecked and windows were blown in and trees torn up. The Hansen, Bedell, Hungerford, and Price homes were totally destroyed. The Southern and Staniforth homes were so badly wrecked that they are practically useless. * * * The storm next swept over State Street and damaged every building from Randall's livery barn as far up as John Hauer's residence, etc.

The reports from cooperative observers for October show a general and moderately heavy rainfall over the State on the 10th. No remarkably heavy amounts were recorded on that day, although the observers at many stations measured amounts of from 1 to 2 inches. Thunderstorms were numerous and at a number of places they were accompanied by hail and destructive wind. The observer at Osceola, a station about 180 miles northwest of the principal tornado track, had the largest 24-hour rainfall, amounting to 2.30 inches.

The second tornado which occurred near Beloit, in Rock County, in the later afternoon was much less severe. It occurred at 4.20 p. m., traveling from southwest to northeast, with length of path about 1 mile. It was of short duration and the width of its path ranged from 8 to 40 rods. Correspondents at Beloit all report a pendent, funnel-shaped cloud with rotary winds. The loss from this storm amounted to about $20,000, which is included in the estimate of $250,000 as a total loss for the entire district. Six people were injured during the tornado near Beloit, and a dozen cattle, two horses, and numerous pigs and chickens were killed, and two houses and six barns were destroyed.

RAINFALL AND SPRING WHEAT.

T. A. BLAIR, Observer, Minneapolis, Minn.

A statistical study of the relations between climates and crops has shown, in a few instances, a very definite correlation between yield and rainfall. In the wheat districts of southern Australia there is a practically constant difference of 6 between the rainfall in inches and the yield of wheat in bushels per acre; and in Jamaica and Barbados the sugar production can be predicted within 3 per cent from the rainfall data. (Hann, Climatology, p. 58.) Although the relations between climates and crops are in general much more complicated, and no one climatic element has such a predominating influence as precipitation in the cases cited above. Nevertheless the supply of moisture during the growing season is one of the largest factors in the production of the staple crops of all countries. The following table and charts have been prepared with a view to ascertaining to what extent the monthly precipitation influences the yield of wheat in the three great spring-wheat-producing States of Minnesota, North Dakota, and South Dakota.

In these States wheat is seeded during April and harvested during the latter half of July and in August. There is always sufficient moisture in the ground in April to start the plant, and by July it has attained its height and is heading, at which time warmth and sunshine are needed and much rainfall is injurious. It is during May and June, therefore, while the plant is growing most rapidly, that the favorable effects of precipitation should be most noticeable. Accordingly, the total rainfall for May and June has been used in making this comparison. The first column for each of the States is the precipitation by years; the second column the departure from the average of the years used; the third is the yield of wheat in bushels per acre, and the fourth the like departure from the average. The rainfall figures used are the State averages obtained by the Weather Bureau, and the figures for yield are those of the Bureau of Statistics, as published in the Yearbooks of the Department of Agriculture. The charts have been so drawn that the two curves for each State have the same base line and the same line representing average values, thus facilitating the direct comparison of the two quantities.

It will be noted that the curves for South Dakota show a remarkably close correspondence between yield and rainfall for several of the years, but considerable divergences in other years; the same is true of North Dakota, while Minnesota shows more marked divergences and less correlation. In particular, the four wettest seasons in Minnesota, in which the rainfall exceeded 10 inches for the two months under consideration, each produced a crop that was below normal, while of the six years with yields decidedly above normal five had less than the average precipitation and the sixth only 0.4 inch above the average. It therefore appears that a wet May and June are distinctly unfavorable for wheat in Minnesota and that the best crops are obtained when the precipitation is normal or slightly less. One evident reason for this is the poor drainage of much of the land in Minnesota. Many fields produce better in dry years because, even in years of ordinary rainfall, they become waterlogged through lack of natural drainage. No such result appears in the Dakotas, where the drainage is better and where also the average precipitation is less, approaching more nearly a semiarid condition, and where for this reason a more direct response to increased rainfall might be expected.

In 10 out of the 22 years' record for Minnesota the departures are of opposite signs, thus indicating no direct relation. From this table the correlation coefficient was calculated in the usual manner (see article, Correlation, J. Warren Smith, Monthly Weather Review, May, 1911), and found to be a very small negative quantity. The 4 wet years above mentioned were then omitted and the coefficient found to be 0.26, with a possible error of 0.11. To show a close correlation the coefficient should not be less than 0.50 and must be six times the possible error. Obviously no such relation exists for wheat production and rainfall in Minnesota.

In the record for South Dakota there are 6 years with departures of opposite sign, but the departures are all small, except for the years 1910 and 1912, which had very light rainfall but above normal yields. The correlation coefficient for South Dakota is 0.59 and the possible error 0.06, showing a very distinct relation between the amount of rainfall in May and June and the resulting harvest. And this is largely true for the individual years, except for the two just mentioned. An especially close relation is shown for the period of 12 years, 1893 to 1904, inclusive, for which the coefficient is 0.87 and the possible error 0.025. The years with the heaviest rainfall show yields well above normal, but not equaling those of 1891 and 1912, when precipitation was below normal.

The correlation coefficient for the whole series of years is greatest in North Dakota, being 0.63, with a possible error of 0.05, but there is not as in South Dakota a long series of years showing a much closer relation. Here also there are 6 years with departures of opposite sign, in several of which there is a rather wide divergence. The years of greatest yield were 1895, 21 bushels, and 1912, 18 bushels, with precipitation, respectively, 1.3 inches and 0.7 inch above normal. The greatest rainfall was 8.7 inches in 1896 and 1906, and the yields in these years were, respectively, 0.4 bushel below the average and 0.8 above. Only in North Dakota was the year of minimum rainfall also the year of minimum yield; but in general, for all three States, years of light rainfall were years of light yield, the exceptions being Minnesota in 1910 and South Dakota in 1910 and 1912.

These years and that of 1911 in North Dakota are the seasons showing the least correspondence of precipitation and yield, and in these there is some indication of the influence of temperature, good yields in dry years being accompanied by cool weather in May, and poor yields in normally wet years by very warm weather. In 1910 the rainfall was very light in all the States, but the yield was above normal in Minnesota and South Dakota, and May